

Can You Hear Me Now?

Acoustic Technology Offers New Force Options

By Andrew Borrello

Our technology has allowed us to send a robotic vehicle 35,000,000 miles through space, land on the surface of Mars, and determine water was once present. There are patients who were once critically ill who are now walking around with man-made hearts providing precious extended life with every mechanical beat. We have supercomputers such as IBM's \$290 million ASCI "Purple" weighing in at 300 tons and boasting a peak speed of 111 trillion bytes per second. With such advanced and still developing technologies, it is disheartening that our police officers, deputies, and agents must rely only on a firearm, an impact weapon, and aerosol spray to protect themselves and the lives of those they serve. Even with the national mass deployment of the electronic Taser—an effective weapon—force technology for today's law enforcement is operating in the Stone Age in comparison to other industries. Despite the lack of technology in law enforcement's arsenal, the near future holds a variety of advanced weapons that are not only less lethal, but nothing less than exciting.

Imagine the technologically advanced police response in the near future...

- An emotionally disturbed man stands in his front yard swinging a large sword screaming he will kill anyone who comes near him. Responding officers deploy a compact high-pressure water bottle containing mineral-laced water. As the tight stream of water is shot at the suspect from a safe distance of forty feet, it is charged

with 50,000 volts and 26 watts. The stream hits the man and the disabling electrical charge spreads with the water as it soaks into his clothing.

- Civil unrest breaks out and protesters turn violent as they start fires, break windows, and throw rocks and bottles. Despite police efforts, the main portion of the mob will not disperse. Several thermal guns are deployed and leveled at the crowd. As the 95 GHz microwave beam is activated, a number of protester's begin to run away or drop to their knees in submission as the temperature of their skin quickly rises from normal to a painful 130 degrees without causing tissue damage.
- As an armed parolee sits in a stolen car after it ran out of gas during a long police pursuit, a standoff ensues as officers plead with the man to exit and surrender. A small tranquility dart hits the suspect's arm through the open window, introducing a powerful calmative agent into the man's body. Within seconds, the parolee slips into blissful sleep.

Beyond such emerging methods of reducing the levels of force is another technology that may develop some of the most interesting and effective weapons on the horizon: the use of acoustic technology utilizing the dynamic manipulation of sound.

THE DYNAMICS OF SOUND

Take a Styrofoam cup and hold it in front of your mouth. As you utter a series of words, you will feel the cup vibrate in your hand as the sound of your voice resonates through the air. As a Harley Davidson accelerates down the street, the de-baffled exhaust system achieves levels of sound that can activate the alarms of the parked cars lining the

street. After a bolt of lightning cuts through the air, an enormous blast of thunder shakes the walls of your house and the shockwaves can be felt inside your chest. One of the most famous demonstrations of the power of sound is the proverbial opera signer who can hit such a powerful and controlled sympathetic tone; the sound of his or her voice can match the resonance of a crystal glass and shatter it. While some think this is fiction, it is said that Enrico Caruso managed to accomplish this feat. In the 1970's, Memorex used a recording of one of the world's best known jazz singers, Ella Fitzgerald, to shatter a glass, generating a famous commercial slogan that is still spoken some thirty years later; "Is it live or is it Memorex?"

The use of sound, high-tech or otherwise, is virtually limitless. We use ultrasound in medicine to see a baby in the womb of its mother and intense pulses of sound to pulverize kidney stones inside our bodies. Sound Navigation and Ranging (SONAR) is used for both plotting courses at sea and detecting enemy submarines deep underwater. Sound is used to alarm us if smoke from fire is detected in our homes while we sleep. It is used to prevent our cars from being stolen and to alert traffic that an emergency vehicle is approaching. Sound is even used tactically in the natural world. According to David Sutton (*Fortean Times*), sperm whales use pulses of infrasound to stun large squid prior to eating them. His recent research even suggests that tigers are able to deliver a physically stunning 18-hertz (Hz) roar immediately before attacking their prey. While sound has thousands of contemporary uses, the research and development of acoustic technology has created less-lethal sonic devices with an assortment of diverse applications. These applications are both dynamic and effective and stem from an intriguing history.

HISTORY OF ACOUSTIC WEAPONS

Researching the history of acoustic weapons technology is a hit and miss endeavor. Much of the available information is cloaked in secrecy and misinformation. Such secrecy stems from unattainable information from the military or government contractor projects, which have not been declassified. Acoustic weapons and their potential often fuel urban legend propaganda. The “conspiracy around every corner” folk have multitudes of information—ranging from serious to silly—claiming acoustic technology is used by covert government entities for mind control and targeted harassment. In the past, manufacturers have provided limited information, as they have competition to think about and have primarily sold their products directly to branches of the military. Despite the drawbacks of researching this subject, a workable trail of historic information is clearly present, primarily spanning the past sixty years.

Researching sound as a potential weapon from a historical perspective may start with the Bible. In the Old Testament, in Joshua (Chapter 6), priests blasted their trumpets and all the people shouted with a great shout, and the seemingly impenetrable walls of Jericho fell flat. In WWII, the Germans pioneered a sound-based weapon called the Luftkanone. In an on-line article, *Sound as a Weapon*, Luftkanon inventor, Dr. Richard Wallauscheck, describes the effects of the Luftkanone, in part, as follows: “... *No physiological experiments were conducted, but it was estimated that at such a pressure it would take from 30 to 40 seconds to kill a man. At greater ranges, perhaps up to 300 meters, the effect, although not lethal, would be very painful and would probably disable a man for an appreciable length of time.*”

In an article called *Wonder Weapons*, author Douglas Pasternak writes that toward the end of WWII, the Germans were reported to have made a different type of acoustic device. The device looked like a large cannon and sent out a sonic boom-like shock wave that, in theory, could have downed a B-17 bomber. In the mid-1940s, the U.S. Navy created a program called Project Squid to study the German vortex technology. The results are unknown or unavailable; however, Pasternak notes American Inventor, Guy Obolensky claimed to have replicated the Nazi device in his laboratory in 1949. Obolensky found that against hard objects, the effect was astounding; it could snap a board like a twig. Against soft targets like people, Obolensky found it had a different effect, stating, *"I felt like I had been hit by a thick rubber blanket."* The idea of the vortex seemed to fail for years until recently, when the U.S. military became interested in its less-than-lethal potential. The Army and the Navy now have vortex projects underway.

In, "Non-lethal Weapons: Terms and References", Robert Bunker identified that in the 1960s, sound was delivered at extreme high volume decibel (dB) levels as demonstrated by the HPS-1 Sound System, which produces 350 watts with an audible voice range of 2½ miles. This system was used by U.S. military in Indo-China and then supplied to law enforcement where it was used at San Francisco State College and at Berkeley College. High decibel sound, which represents acoustic weapon technology of the past, has been used to harass (create stress and sleep deprivation) and control by repelling troops or rioters from specific areas or directions.

During the Vietnam War in the early 1970s, our military experimented with and used sonic (sound) weapons known as the "Curdler" or "People Repeller" and the

“Squawk Box.” The program that employed these weapons was known as the Urban Funk Campaign. In an article called, *Deadly Vibrations*, B.G. Nichols provides the following description of the curdler: “...A sonic weapon known as the ‘Curdler’ or ‘People Repeller’ was employed to disrupt unruly crowds, and generally irritate the enemy during the night. Audio frequency oscillators were mounted on helicopters, and blasted frequencies at ‘Charlie’, ranging from 500-5000 Hz at an amplitude of 120 dB - equivalent to the roar of a jet engine at close quarters. This was a highly effective panic-inducing weapon, which was also reputedly deployed during the height of the Northern Ireland conflict.

Nichols also describes the “Squawk Box” as: “Mounted on a Land Rover or similar carrier vehicle, this device housed in a 3ft cube was able to emit two marginally different frequencies (eg. 16,000 & 16,002 Hz). These component frequencies, their sum and difference, produced a subsonic harmonic of 2 Hz (infrasound). Its effective beam was so small and directional that it could target individuals, producing ‘spooky’ psycho-physiological effects such as panic, vomiting, and seizures. It is worthy of note that infrasound is particularly effective in the arousal of fear or anxiety.”

As past history meets today’s advanced technology, acoustic weapon research and development in acoustic weapon technology is rapidly advancing, especially in the U.S. Understanding the science behind perfecting a less-lethal sound weapon is complex. A simplistic explanation of sound used as a weapon is the development of a directional system that can deliver a focused pulse of sound at a high dB level, which is so loud that it becomes intolerable for the target to bear. An average refrigerator emits sound at

approximately 45 dB. A car driving by on the roadway registers at approximately 70 dB. An air raid siren blasts sound at about 130 dB and a human's threshold of pain is about 140 dB, which is considered the danger level for one's hearing. Sound weapons can send focused and sustained sound down range in excess of 146 dB, which is nearly the auditory equivalent to the roar of a jet turbine.

More recent information stemming from a 1996 report developed by Scientific Applications & Research Associates (SARA), illustrates, in part, how various applications of sound used as a weapon can affect the human body. The report states that with respect to effects on humans, some of the applications are: Infrasound at 110-130 dB would cause intestinal pain and severe nausea. Extreme levels of annoyance or distraction would result from minutes of exposure to levels 90 to 120 dB at low frequencies (5 to 200 Hz), strong physical trauma and damage to tissues at 140-150 dB, and instantaneous blast-wave type trauma at above 170 dB. At low frequencies, resonance in the body would cause hemorrhage and spasms; in the mid-audio range (0.5-2.5 kHz) resonance in the air cavities of the body would cause nerve irritation, tissue trauma and heating; high audio and ultrasound frequencies (5 to 30 kHz) would cause heating up to lethal body temperatures, tissue burns, and dehydration; and at higher frequencies or with short pulses, bubbles would form from cavitations and micro-lesions in tissue would evolve. As acoustic technology progresses into modern day, the development and manufacturing of acoustic devices has become both prevalent and highly applicable for a number of security and law enforcement uses.

ACOUSTIC WEAPONS TODAY

There are several manufacturers currently developing acoustic technology for use by law enforcement, however, such companies are careful not to describe their products as weapons. Outside the military arena, force may be referred to with a softer descriptor such as behavior modification and the term, “communication device” or “force protection” is preferred over “weapon”. Despite how the devices are marketed, today’s acoustic technologies have multi-use applications and any device that has the ability to influence, repel, or control a combative individual or a crowd on the verge of rioting has great value to law enforcement.

The SARA lab, located in Cypress, California, develops a variety of futuristic non-lethal weapons. Among them is a directional “Sonic Fire Hose”. This sonic weapon is described as acoustic energy that can be focused to deliver intense sound to a selected target, creating a non-lethal deterrent. Deterrent ranges in excess of 1 km (3,281 feet) have been demonstrated. Man-portable prototypes are now operating in SARA’s labs.

Perhaps the most prolific manufacturer is the American Technology Corporation (ATC) in San Diego, California. ATC had developed and marketed the LRAD 1000 (Long-Range Acoustic Device) and the LRAD 500, a smaller and more portable version of the LRAD 1000. The LRAD 1000 looks like a large circular speaker measuring 33 inches in diameter, weighing approximately 45 pounds, and costing approximately \$35,000.00 per unit.

The LRAD 1000 has been purchased extensively by US military forces and is currently deployed and heavily used in Iraq. The need for powerful long-range

hailing/warning devices was realized after the attack on the USS Cole that occurred in Yemen in October 2000. The LRAD is able to deliver clear warnings to watercraft beyond the 100-yard warning zone and into the 500-yard exclusion zone to either gain compliance or determine intent. Today, the LRAD is used in all types of military vehicles and helicopters, and is employed by the US Coast Guard, the US Border Patrol, by commercial cruise ships, and in a variety of port locations. Currently, the LRAD is being marketed and demonstrated for use by law enforcement.

The LRAD 500 can put 142 dB down range and when used for communications, can deliver crystal clear messages up to 500 meters. During a demonstration of the LRAD 500, the device was aimed at a group of police officers approximately 120 feet away. As the pre-recorded message was broadcasted from the unit's MP3 player, it sounded as if the voice was only inches away from the officer's ears and the quality of the sound was impressively sharp and free from any distortion. The alert tone or warble was activated and immediately convinced the officers that moving closer to the device would not be in their best interest. With such capabilities, advanced acoustic devices offer diverse advantages for law enforcement: mass communication during major emergencies; delivering orders at distance in ports or at sea for protection, drug enforcement, or boarder protection; controlling individuals or crowds through auditory pain from high-volume applications; or keeping adversary gangs apart in prison. The applications for law enforcement are many and continue to grow as the technology pushes forward.

HPV Technologies in Costa Mesa, California has recently developed a high-tech sound output technology called MAD (Magnetic Audio Device) utilizing extremely powerful magnets in planar magnetic transducers. These transducers resemble speakers, but are only 9.25" tall, 6" wide, and 3/4" thick. When the transducers are combined into 2-packs, 4-packs, or more, the sound produced is astounding. Commander Sid Heal (Los Angeles Sheriff's Department) is an internationally recognized expert on less-lethal weapons and has tested the MAD system. During an interview with Commander Heal, he stated the following:

"The Magnetic Acoustic Device (MAD) was one of those surprises you never really expect. We discovered it more by keeping an open mind and our work ethic of "leaving no stone unturned" than by any investigative prowess. Once we saw (heard) the demonstration we were quite literally blown away (no pun intended!). At 100 yards the sound was so clear that you could hear every note of the song, not to mention that you could actually feel it, and because it relies on a planar wave instead of the conventional acoustic wave, it was not unbearable even at the source! The scientists at HPV Technologies boasted that we could not "burn out" their speakers and that they could make the sound go one-mile. Having heard similar boasts from other developers in the past, we took the challenge. I arranged for a 60KW Battle Generator with crew for power and we measured a statute mile with a GPS at our facilities in Saugus. Guess what? It performed as described. Even with 60,000 watts the magnets remained unharmed and I personally listened to a Frank Sinatra record at one mile! This distance defies description since you can no longer see the source after about a half-mile, yet we could clearly hear the lyrics and back ground music."

“Our initial efforts of using the device for domestic law enforcement applications will be with replacing or augmenting the conventional “hailing” and alerting bullhorns and other loud speakers. Three smaller devices are being built for our Special Enforcement Bureau and will be put in field trials this spring. But, because the human brain is more sensitive to some frequencies than others, we see its greatest potential for use as a less lethal option. A common example might be the revulsion many experience with the sounds of squeaky chalk or fingernails on a blackboard. Without requiring dangerous sound pressure levels, the mere frequency might be enough to deter, dissuade, and discourage people involved in unlawful activities. In this manner, acoustics might be used similar to tear gas but without the adverse environmental concerns or residual effects, especially decontamination and cross-contamination”.

During a visit to HPV headquarters, I was given a demonstration of a hand-held device resembling a bullhorn. This prototype is being custom-designed for law enforcement use. I stood about 250 feet away and the directional device played a pre-recorded message that was so loud that the sound appeared to be coming from everywhere and the quality of the sound was perfectly clear, without any hiss or distortion. Back in the lab, I experienced transducer arrays from 2-packs up to dual 64-packs playing sounds that included Pink Floyd and 50-caliber machinegun fire. The sound quality and power of these transducers was simply amazing and once employed for general law enforcement applications, the MAD system will offer a wide a variety of beneficial uses.

As acoustic technology transitions from military applications to the law enforcement industry, use of these sonic devices are becoming well publicized. Two LRADs were purchased by the New York City Police Department, perhaps the first American law enforcement organization to add an acoustic device to their arsenal. In an article titled, *Authorities to Turn Up the Volume for GOP Convention – A 150-decibel Megaphone*, Tom Hays describes the LRADs as being mounted on armored police vehicles during the 2004 Republican National Convention. Although they were not deployed in a defensive or offensive manner, they were used as a communication device in Times Square to deliver messages that could be heard clearly and evenly for four blocks.

In June 2005, Santa Ana (CA) Police Department's SWAT team borrowed an LRAD 1000 and used it during the execution of a search warrant to deliver commands. When the occupants failed to exit the house, the LRAD's alert tone was activated. After panning the house with an excruciating high-pitched warble, the ten occupants were effectively driven outside the house. In November 2005, news sources reported pirates who were armed with automatic rifles and a "bazooka" attacked a cruise ship, located in the dangerous waters off the coast of Somalia. The ship's crew mounted an LRAD during the attack and focused the sonic device toward the pirates. This served to help ward off their attack and prevented the pirates from getting close enough to board the ship. HPV is currently designing a custom made MAD package to be integrated into an emergency command vehicle for the Los Angeles County Sheriff's Department.

THE FUTURE OF ACOUSTIC WEAPONS

The future potential of these weapons as they are continually modified and improved to meet specific needs is immense. When Taser International's M26 Electronic Taser was manufactured and law enforcement learned it was safe and effective, it only took several years for nearly every law enforcement agency in the country to purchase and deploy it. There is little doubt that tomorrow's advanced acoustic devices will enjoy the same wide-scale acceptance from law enforcement.

Focusing specifically on law enforcement applications over the next ten years, forecasting the future of acoustic devices suggests they will become smaller, lighter, and handheld for personal defensive protection. They will also be designed and manufactured as made-to-order devices. In other words, there will be acoustic devices for large crowds, riots, correctional institutions (prisons), and border patrol to name a few. There will be devices made specifically for tactical, protective, and long-range communication; there will be acoustic weapons for use as an offensive and defensive weapon with applications ranging from low levels of force to lethal force.

As law enforcement organizations see the early devices field tested successfully and adopted by a handful of progressive agencies, demand will begin to grow. As the demand grows and more organizations adopt acoustic technology, private manufacturers will begin to benefit from a potentially explosive market. As a result, the acoustic devices will continually improve, being modified and re-modified (smaller, stronger, more effective) for manufacturers to remain competitive. Acoustic devices will eventually become a regular part of law enforcement's protective compliment of less-lethal

weapons. New uses for the devices may also be realized to include: serving as unmanned sentries that deny entry to a restricted area; operating as sonic fences to stop escapes by prisoners; and preventing unlawful entry across U.S. borders.

The most important aspect regarding the potential future of acoustic weapons is once perfected; they will provide officers with a more effective method to deliver reasonable and humane force at a distance without risking their physical safety and without causing serious injury to the suspect. Today, our police officers push riotous crowds back with physical force, riot batons, horses, tear gas, and rubber-pellet grenades. Tomorrow, focused beams of invisible and incapacitating *silent sound* delivered from 100 meters away may disburse the same riotous crowd in a safer and more efficient manner.

While the positive aspects of adopting acoustic weapons into law enforcement are abundant, the negative, especially with regard to police weapons and force applications, often accompany the positive. When acoustic weapon systems become perfected and are integrated into mainstream law enforcement organizations, there may be resistance to such weapons by certain groups. Just as Amnesty International challenged Taser International, acoustic technology will inevitably suffer its own trials and tribulations. We can count on adverse media attention as well as the common propaganda from a variety of self-proclaimed civil rights activists. Such adverse claims may include concerns whether the weapons are humane or not, and if they might be used as a torture device to elicit confessions by using modifications to create higher levels of force. Anti-establishment and conspiracy-based factions of society may be convinced that acoustic weapons are just more tools, used by a powerful invasive government, to control or

harass people. Despite the advanced technology or reasonable application of acoustic weapons, injuries will occur. Claims may be made that the weapon permanently damaged a suspect's hearing and that such force is excessive force, despite the lawful and reasonable use of the weapon or the successful outcome.

The adoption and application of any effective weapon by law enforcement will always enjoy the benefits and endure the battles common to this unique line of work. For the future potential of acoustic weapons to be successful, they must be implemented strategically and through a developmental transition process that adheres to in-depth criteria and high standards. The following list is illustrative rather than conclusive and identifies the critical fundamental standards and criteria that must be met for the future inclusion of acoustic weapons into law enforcement's contemporary arsenal.

This 15-step criteria-based checklist illustrates how acoustic weapons may transition into law enforcement: 1) Must be approved by legal, medical, and subject matter expert professionals; 2) Must be safe for the user; 3) Must be controllable with known results; 4) Must not cause permanent injury/damage if used as intended; 5) Must be equipped with safety features to avoid misuse, mistakes, or use by unauthorized persons; 6) Must be defensible in court and not expose agencies to unreasonable civil liability; 7) Must be portable; 8) Must be easily maintained and deployed; 9) Must be highly directional; 10) Must not easily be defeated; 11) Must be effective at varied distances; 12) Must have formal and verifiable certified training for those who operate the weapon; 13) Must have a reliable and practical power source; 14) Must be acceptable

to public perception as an effective and humane weapon; and 15) Must be reasonably affordable.

Once acoustic weapons meet the aforementioned criteria, law enforcement will have an effective less-lethal weapon that has the potential to render the most violent of suspects safely incapacitated. The selectable force applications will include high dB volume and blended sound frequencies to produce varied results, thus providing officers with the flexibility to best address a variety of situations. Such results might include forcing a suspect to cover his ears, thus exposing his hands or to drop to his knees. Sonic pulses may force the suspect to vomit; to be forced out of a location or hiding place; to have an instant severe headache compounded with dizziness; or to be knocked off his feet without injury or blunt force trauma. Sound can penetrate walls to deliver instructions or communicate with a hostage while the suspect is in another room. Theoretically, blended levels of sound, combined and delivered with sufficient volume and energy, have the power to level a large building. Ideally the future will equip officers with acoustic weapons about the size of a loaf of bread that can safely and quickly incapacitate a suspect until he can be physically controlled.

CONCLUSION

The history of acoustic weapons is certainly intriguing. They have been used regularly in the military, but to what extent is unknown (classified or unpublicized). The conceptual aspect of sonic weapons may seem like science fiction as portrayed in movies like "Dune" or "Minority Report", but while these weapons may seem to be products of the future, they exist today and are being used to fight the war on terrorism in Iraq.

Acoustic weapon technology is just beginning to transition to the needs of the law enforcement industry. These weapons are already for sale, but have a ways to go before the average officer or tactical team can consider them for daily use in the field. Manufacturers and their engineers are working in their labs and they are researching, testing, and developing the sonic weapons of tomorrow. Mainstream introduction and national adoption of long-range acoustic weapons promise to offer wide-ranging opportunities, diverse challenges, and a substantial impact as a new and effective force option for tomorrow's law enforcement officer.

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